SAVITRIBAI PHULE PUNE UNIVERSITY, PUNE

(*Formerly University of Pune*)

Two-Year Post Graduate Programme in Geography

Faculty of Science and Technology

Choice Based Credit System (CBCS)

Syllabi for

M.Sc. Geoinformatics

Department of Geography, Savitribai Phule Pune University

Syllabi as per guidelines of National Education Policy 2020

To be implemented from Academic Year 2023-2024

SAVITRIBAI PHULE PUNE UNIVERSITY, PUNE

Department of Geography

Syllabi as per NEP 2020 for M.Sc. Geoinformatics

Title of the Programme: M.Sc. Geoinformatics

Preamble:

National Education Policy 2020 lays particular emphasis on the development of creative potential of each individual. It is based on the principle that education must develop not only cognitive capacities - both the foundational capacities of literacy and numeracy and higher order cognitive capacities, such as critical thinking and problem solving - but also social, ethical, and emotional capacities and dispositions. On behalf of new education policy Savitribai Phule Pune University has decided to change the syllabi of various faculties from June 2023. Taking into consideration the rapid changes in science and technology and new approaches Geographical Information System and Remote Sensing, Board of Studies in Geography after a discussion with the teachers of Geoinformatics in Geography Department, Savitribai Phule Pune University and all stakeholders has prepared the syllabus of M.Sc. Semester-1 and Semester-II (w.e.f. 2023-2024) Geoinformatics programme under the Choice Based Credit System (CBCS). The model curriculum as developed by NEP 2020 is used as a guideline for the present syllabi. The syllabi focus on credits related to major core, major elective, research methodology, internship/On job training and research projects.

Aims and Objectives of the new curriculum:

1. To update the curriculum as per the NEP 2020.
2. To incorporate recent development in the field of GIS and Remote Sensing.
3. To enhance the quality and standards of knowledge of geospatial technology.
4. To provide a broad common framework, for exchange, mobility, free dialogue across the global GIS and Remote sensing Community.
5. To provide students with a comprehensive understanding of these two interconnected fields and equip them with the necessary knowledge and skills to apply remote sensing and GIS technologies in various applications.
6. To maximize the efficiency of decision making and planning using GIS and Remote Sensing.

7. To introduce students to spatial programming as a way to automate common GIS tasks as a way to increase accuracy and reduce drudgery.
8. To strive to strike a balance between proprietary and all-open-source technologies in GIS.
9. Provide job-oriented skills to the students with multiple entry and exit option.
10. To enhance employability and entrepreneurship skill among the students in local and global market.
11. To develop research and innovative skill among the students blended with the use of geospatial technology.
12. Reinforce the theoretical knowledge, to work on real-world projects and gain practical experience in data collection, analysis, and interpretation.
13. Emphasize the importance of staying updated with the latest developments in GIS programming and explore emerging trends in the field.
14. Introduce students to the basics of programming languages commonly used in GIS, such as C, Python, JavaScript, R, .NET and their application in spatial data manipulation and analysis.
15. Teach students how to write scripts and programs that automate repetitive tasks in GIS, allowing for more efficient and consistent data processing.

Program Outcomes:

By the end of the program the students will be able to:

1. explain relevant terms and concepts of GIS and Remote Sensing including definitions.
2. give better explanation about relevant principles, theories and models in Geoinformatics.
3. understand the basic principles and concepts of GIS, including spatial data representation, coordinate systems, map projections, and spatial analysis techniques.
4. handle GIS software packages such as ArcGIS, QGIS, or other relevant tools. They should gain hands-on experience with data input, data management, cartography, and geospatial analysis using these tools.
5. show clear knowledge and identify the importance of application of GIS and RS in various disciplines.
6. identify the importance of spatial scale and time scale.
7. learn methods for gathering and integrating various types of spatial data from different sources, such as GPS data, satellite imagery, and online data services.

8. identify real-world problems that can be addressed using GIS, formulating appropriate spatial questions, and applying GIS techniques to solve those problems.
9. identify the importance of the resemblances and variance between places, environments and people.
10. develop a spatial mindset, which involves thinking critically about spatial relationships, patterns, and processes in the real world.
11. interpret a variety of types of geographical data and sources and recognize their limitations.
12. demonstrate skill of analysis and synthesis of geographical information.
13. to understand the methods and theories of programming for GIS that will allow students to apply GIS knowledge and skills to everyday life.
14. gain an understanding of the ethical and legal implications of using GIS, including privacy concerns, data sharing, and intellectual property rights.

SAVITRIBAI PHULE PUNE UNIVERSITY

Syllabi as per NEP 2020 for M.Sc. Geoinformatics (Level 6.0)
Department of Geography, Savitribai Phule Pune University

M.Sc. Geoinformatics (Year I, Semester I)

Level	Semester	Group	Course Code	Course Title	Credits		Total Credits
					T	P	
6.0	First Semester	**Major Core**	GIS 101	Fundamentals of Remote Sensing and Photogrammetry	04	--	04
			GIS 102	Practicals in Spatial Data Processing	--	04	04
			GIS 103	Fundamentals of GIS	02	--	02
			GIS 104	Applied Statistics - I: Theory	02	--	02
			GIS 105	Database Management Systems	02	--	02
				Total credits related to Major Core	**10**	**04**	**14**
		Major Electives (Theory is mandatory, select any one of the following practical courses)	GIS 111	Applied Statistics - I: Practicals	--	02	02
			GIS 112	Basic Programming Concepts	02	--	02
			GIS 113	Basic Programming with Python	--	02	02
				Total credits related to Major Elective	**02**	**02**	**04**
		Research Methodology	GIS 121	Research Methodology	**04**	**--**	**04**
			Sem I Total Credits= (Major Core + Major Elective + RM)		**16**	**06**	**22**

Vertical Group (Semester – I)	**Credits for Theory**	**Credits for Practical**	**Total Credits**
Total Credits related to Major Core	10	04	**14**
Total Credits related to Major Electives	02	02	**04**
Research Methodology	04	--	**04**
Total Credits	**16**	**06**	**22**

M.Sc. Geoinformatics (Year I, Semester II)

Level	Semester	Group	Course Code	Course Title	Credits		Total Credits
					T	P	
6.0	Second Semester	**Major Core**	GIS 201	Digital Image Processing	04	--	04
			GIS 202	Geospatial Analysis	04	--	04
			GIS 203	Advance Surveying and fieldwork: Theory	02	--	02
			GIS 204	Advance Surveying and fieldwork: Practicals	--	02	02
			GIS 205	Open Source GIS - I	--	02	02
				Total credits related to Major Core	**10**	**04**	**14**
		Major Electives (Theory is mandatory, select any one of the following practical courses)	GIS 211	Applied Statistics – II: Practicals	--	02	02
			GIS 212	Advance Programming with Python	--	02	02
			GIS 213	Cartography and Data Representation	--	02	02
			GIS 214	Applications of GIS and Remote Sensing	02	--	02
				Total credits related to Major Elective	**02**	**02**	**04**
		On Job Training	GIS 221	**On Job Training** (Students should complete on job training not less than 60 clock hours)			**04**
			Sem II Total Credits = (Major Core +Major Elective + OJT)		**12**	**06**	**22**

Vertical Group (Semester – II)	**Credits for Theory**	**Credits for Practical**	**Total Credits**
Total Credits related to Major Core	10	04	**14**
Total Credits related to Major Electives	02	02	**04**
On Job Training	--	04	**04**
Total Credits	**12**	**10**	**22**

SAVITRIBAI PHULE PUNE UNIVERSITY

Syllabi as per NEP 2020 for M.Sc. Geoinformatics (Level 6.5)
Department of Geography, Savitribai Phule Pune University

M.Sc. Geoinformatics (Year II, Semester III)

Level	Semester	Group	Course Code	Course Title	Credits		Total Credits
					T	P	
6.5	Third Semester	**Major Core**	GIS 301	Advances in Remote Sensing and GIS: Theory	04	--	04
			GIS 302	Practicals in Advance Remote Sensing and GIS		04	04
			GIS 303	Thermal and Microwave Remote Sensing	02	--	02
			GIS 304	Hyperspectral and LASER Remote Sensing	02	--	02
			GIS 305	Web GIS and Google Earth Engine	02	--	02
				Total credits related to Major Core	**10**	**04**	**14**
		Major Electives (One theory is mandatory, select any two of the following courses)	GIS 311	Artificial Intelligence and Machine	02	--	02
			GIS 312	Concepts and Methods in Data Sources Exploration	02	--	02
			GIS 313	Programming in Java Script	--	02	02
			GIS 314	Programming in .Net	--	02	02
			GIS 315	Open Source GIS - II	--	02	02
				Total credits related to Major Elective	**02**	**02**	**04**
		Research Project	GIS 321	Research Project			**04**
			Sem III Total Credits = (Major Core +Major Elective + RP)		**12**	**06**	**22**

Vertical Group (Semester – III)	**Credits for Theory**	**Credits for Practical**	**Total Credits**
Total Credits related to Major Core	10	04	**14**
Total Credits related to Major Electives	02/04	02/00	**04**
Research Project	--	04	**04**
Total Credits	**12/14**	**10/08**	**22**

M.Sc. Geoinformatics (Year II, Semester IV)

Level	Semester	Group	Course Code	Course Title	Credits		Total Credits
					T	P	
6.5	Fourth Semester	**Major Core**	GIS 401	Applications of Remote Sensing and GIS in Geosciences and Hydrology	02	--	02
			GIS 402	Applications of Remote Sensing and GIS in Agriculture and Soil	02	--	02
			GIS 403	Applications of Remote Sensing and GIS in Forest and Biodiversity	02	--	02
			GIS 404	Applications of Remote Sensing and GIS in Ocean and Atmosphere	02	--	02
			GIS 405	Project Management	--	02	02
			GIS 406	Applied GIS	--	02	02
				Total credits related to Major Core	**08**	**04**	**12**
		Major Electives (Select any two of the following courses)	GIS 411	Applications of Remote Sensing in Urban Planning and Settlement	02	--	02
			GIS 412	Applications of Remote Sensing in Planetary Science	02	--	02
			GIS 413	Applications of Remote Sensing and GIS in Disaster Management	02	--	02
			GIS 414	Applications of Remote Sensing and GIS in Health and Energy	02	--	02
				Total credits related to Major Elective	**04**	**00**	**04**
		Research Project	GIS 421	Research Project: Dissertation			**06**
			Sem IV Total Credits = (Major Core +Major Elective + RP)		**12**	**04**	**22**

Vertical Group (Semester – IV)	**Credits for Theory**	**Credits for Practical**	**Total Credits**
Total Credits related to Major Core	08	04	**12**
Total Credits related to Major Electives	04	--	**04**
Research Project: Dissertation	--	06	**06**
Total Credits	**12**	**10**	**22**

Year-I
Semester-I

Code: GIS 101 Fundamentals of Remote Sensing and Photogrammetry

No. of Credits: 04 **No. of Lectures: 60**

Course Objectives:

1. To introduce the basic principles of remote sensing.
2. To be familiar with Indian space missions and satellite sensors characteristics.
3. To know the different types of satellite data products, visual interpretation.
4. To provide basic exposure to radiometry and spectroscopy.
5. To understand underlying concepts of aerial photo and photogrammetry.

Sr. No.	Topics	Lectures
1	Introduction to Remote Sensing: Concepts, Definition, Development, Overview of Remote Sensing System.	4
2	Physics of Remote Sensing: Electromagnetic radiation (EMR), Theories of EMR, Laws of Radiation, EM Spectrum, Sources of EMR	8
3	Interaction of EMR: Interaction between radiation and matter, Interaction with Earth's Atmosphere, Atmospheric Window, Reflection, Absorption, and Transmission.	6
4	Spectral Signature: Spectral Signatures for common features, e.g. Snow, Soil, Water and Vegetation.	4
5	Platform and Sensors: Platforms, Sensors, Orbits: Types of Platform, Types of Sensors- Active and Passive, Cameras and Satellite Orbits, Concept of Resolution, Satellite Imaging modes.	8
6	Fundamentals of Radiometry: Concept of solid angle, radiometric measurements, observation geometry in RS.	4
7	Data Products and RS data errors: Satellite Data Generation, Data reception, Type of data products and Aerial Photography Products, FCC and TCC images and their applications, radiometric, geometric and atmospheric errors.	6
8	Photogrammetry: Basic aerial Photography, Basic geometry of aerial photograph, central and orthographic projections, difference between map and aerial photograph, Types of aerial photographs.	4
9	Measurements: Scale and ground coverage of aerial photograph, Geometry of Aerial Photographs, Determination of Scale, Use of Parallax, height measurement.	4
10	Aerial Photo and Image Interpretation: Elements of visual interpretation for aerial photos and satellite imageries: Single, Vertical Stereo Pairs, Derived From PAN, LISS, Wifs, OCM Sensors. Study and Visual Interpretation of Satellite Images for Physical Features, Urban, Forest and Agricultural Uses.	6
11	Stereo Photogrammetry: Introduction, orientation of aerial photographs – inner, relative, absolute orientation, Collinearity and Coplanarity conditions, Concept of Rotation Matrix.	2

12	Digital Photogrammetry: Concept and Techniques of Digital Photogrammetry, Data Generation and Research Application of Cartosat-1 Data, Lidar-altimeter.	3
13	Field Work/Study Tour: Identification of Features in the Field Using Aerial Photographs and Satellite Images	1

Course Outcomes:

By the end of the course, students will be able to

1. understand the basic principles of remote Sensing and Photogrammetry.
2. obtain knowledge of the sensor characteristics of various RS Systems
3. acquire knowledge of different missions & their utility
4. understand functioning, data acquisition and orbit operations of missions.

Suggested Readings:

1. Campbell, J. (2002): Introduction to Remote Sensing, Taylor & Francis, London
2. Jensen, J. R. (2005): Introductory Digital Image Processing, Prentice Hall, New Jersey
3. Joseph, G. (2004): Fundamentals of Remote Sensing, Universities Press, Hyderabad, India
4. Lillesand, T. M., Kiefer, R. W. and Chipman, J. W. (2008): Remote Sensing and Image Interpretation, John Wiley & Sons, New Delhi
5. Sabins, F. F. (1996): Remote Sensing: Principles and interpretation, W.H. Freeman and Company, San Francisco

Code: GIS 102 Practicals in Spatial Data Processing

No. of Credits: 04 **No. of Practicals: 15**

Course Objectives:

1. To develop an understanding of basic skills necessary to work with Geographic Information Systems (GIS), using ESRI's ArcGIS software.
2. To learn about GIS data types.
3. To learn spatial data visualization techniques and cartography, aerial photo, stereo pairs in 3D.
4. To learn geo-processing tools and Spatial query and data extraction.

Sr. No.	Topics	Practicals
1	Overview of GIS software: ArcGIS Desktop, Arc Pro, Arc catalogue, Arc tool Box	1
2	Attribute Data: Creation of Schema, Tables, Data Definition, Data Input, Data Updating, Queries on Tables, Simple-Complex Query with two or more tables using SQL; Queries using Union, Intersection, Join Operations; Use of MS Excel and MS Access	1
3	Spatial Data: Vector/Raster Data Formats with File Extensions, Find and Identify features, attributes and values, select features of vector files, create vector layers, Compute geometry - line and area measurements, convert coordinates between reference systems, Topology creation and editing	3
4	Geodatabase: Feature Dataset, Feature Classes, Import of Data, Spatial Data Formats, Shape/Coverage Files and Layers	1
5	Georeferencing: Image georeferencing, Coordinate Systems, Datum Conversions, Map Projections, Types, Image to Image georeferencing, vector to raster georeferencing	1
6.	Study of Satellite imagery: Visual Interpretation in different bands, study with B/W images, B/W IR, Color IR mages, TCC, FCC	2
7	Spatial Processes: Spatial Joins with Tabular data, Clip Raster to Polygon, Extract values of raster from a point shape file, Clip vectors, Distance Computations on feature data, Editing Data: Selecting Features, Simple Editing Functions, Creating New Features, Modifying, Schema Changes, Spatial Analysis: Query by Attribute and Location	3
8	Map Creation: Building a map, Layer File, Preparation of Base Map, Map Layouts, Scale, Legends, Annotations, Labels, Creation of Graphs and Reports	1
9	Photogrammetry: Location of nadir and principal point on aerial photos, Determination of height from single vertical aerial photograph, Orientation of stereo model under mirror stereoscope, Tracing details from stereo pair, Use of parallax bar and determination of heights	1
10	GPS: GPS Survey, Data Import, Processing and Mapping	1

Course Outcomes:

By the end of the course, students will be able to

1. understand basic spatial analysis techniques: georeferencing, spatial statistics.
2. create datasets in GIS using ESRI ArcGIS Software.
3. identify key concepts related to GIS/Remote Sensing and explore how to apply them to solve real-world problems.
4. identify required data sources, design data preparation and advanced techniques in order to achieve a geospatial solution.

Note: a) For 4 credits 2 hours practical twice a week.
b) The concerned teacher may add some points related to the subject.

Suggested Readings:

1. Bailey, T. C., & Gatrell, A. C. (1995). *Interactive spatial data analysis* (Vol. 413, No. 8). Essex: Longman Scientific & Technical.
2. Bao, J., Tsui, Y. (2005): Fundamentals of Global Positioning System Receivers, John Wiley Sons, Inc., Hoboken.
3. Environmental Systems Research Institute, Inc. (1998): Understanding GIS: The ARC/INFO Method, ESRI Press, Redland
4. Fotheringham, S., & Rogerson, P. (Eds.). (2013). *Spatial analysis and GIS*. Crc Press.
5. Longley, P. (2003). *Advanced spatial analysis: the CASA book of GIS*. ESRI, Inc.

Code: GIS 103 **Fundamentals of GIS**

No. of Credits: 02 **No. of Lectures: 30**

Course Objectives:

1. To understand the core concepts of Geographic Information Systems.
2. To get acquainted with popular GIS software and their functionalities.
3. To learn about various data models (vector and raster), data types, and data structures used in GIS.
4. To learn about spatial analysis methods, including spatial query, buffering, overlay, interpolation, and network analysis.
5. To understand how to apply these techniques to solve spatial problems.

Sr. No.	Topics	Lectures
1	Introduction to GIS: Definitions, Evolution, Components and Objectives	3
2	Overview of GIS Software Packages	2
3	Spatial Data: Concepts of Space and Time, Layers Coverage, Spatial Data Models, Representation of Geographic Features in Vector, Raster Data Models, Concept of Arc, Node, Vertices and Topology	5
4	Object Oriented Models: Advantages and Disadvantages, Computer Representation for Storing Spatial Data: Block Code, Run-Length Encoding, Chain Coding, Quadtree, Issues Governing Choice of Models	5
5	Non-Spatial Data: Advantages of Data Base Management System. Conceptual Implementation Models, Hierarchical, Network, and Relational Models	5
6	Relational Database Management System: Components, Concept, Database Schema, Tables and Relationships, Database Design Normalization (1NF, 2NF, 3NF Forms) Data Definition Manipulation using SQL, SQL-Query Processing, Operations on Tables, Integrity Constraints, Database Security, Role of Database Administrator (DBA), Metadata	5
7	Spatial Data Input: Digitization, Error Identification, Errors: Types, Sources, Correction; Editing and Topology Building	5

Course Outcomes:

By the end of the course, students will be able to

1. equip with a comprehensive understanding of GIS theory
2. understand data concepts and spatial analysis techniques, preparing them to apply GIS knowledge effectively in a wide range of applications and pursue more advanced GIS studies or professional opportunities.

Suggested Readings:

1. Chang, K. T. (2008): Introduction to Geographic Information Systems, Avenue of the Americas, McGraw-Hill, New York
2. Demers, M. N. (2000): Fundamentals of Geographic Information Systems, John Wiley and Sons, New Delhi
3. Korte, G. B. (2001): The GIS Book, Onward Press, Bangalore
4. Lo, C. P., Yeung, A. W. (2002): Concepts Techniques of Geographical Information Systems, Prentice-Hall of India, New Delhi

5. Longley, P. A., Goodchild, M. F., Maguire, D. J., Rhind, D. W. (2002): Geographical Information Systems and Science, John Wiley & Sons, Chichester

Code: GIS 104 Applied Statistics – I: Theory

No. of Credits: 02 **No. of lectures: 30**

Course Objectives:

1. To learn the theoretical part of statistical techniques.
2. To learn the advantages and application of different statistical techniques for different analysis.
3. To study comparison and conclusions of data.
4. To learn about the concepts related to geographical data and its types.

Sr. No.	Topics	Lectures
1	Geographic Data: Sources, Types, Discrete and Continuous Series, Scales of Measurements, Population, Sample and Sampling Techniques	10
2	Organization of Data: Frequency Distribution, Measures of Central Tendency, Dispersion, Skewness and Kurtosis	10
3	Correlation and Regression: Concepts and Methods, Types of Regression: Simple and Multiple	10

Course Outcomes:

By the end of the course, students will be able to

1. understand analysis of data and drawing conclusions from it.
2. understand distribution of spatial data, how things are changing over time and planning, designing, collecting data, analyzing, drawing meaningful interpretation and reporting of the research findings.

Suggested Readings:

1. Ebdon, D. (1977): Statistics in Geography, Basil Blackwell, Oxford
2. Frank, H. and Althoen, S.C. (1994): Statistics: Concepts Applications, Cambridge University Press,Cambridge.
3. Gregory, S. (1978): Statistical Methods for Geographers, Longman, London
4. Hammond, R. and McCullagh, P. (1991): Quantitative Techniques in Geography, Clarendon Press, Oxford
5. Rogerson, P. A. (2010): Statistical Methods for Geography, Sage Publications, London

Code: GIS 105 **Database Management System**

No. of Credits: 02 **No. of Lectures: 30**

Course Objectives:

1. To present an introduction to database management systems.
2. To organize, maintain and retrieve - efficiently, and effectively - information from a DBMS.
3. To understand the relational database design principles.
4. To master the basics of SQL and construct queries using SQL.

No.	Topics	Lectures
1	Database concepts: introduction to database concepts and its need, relational databases, database architecture	2
2	Data Models: The importance of data models, Basic building blocks, The evolution of data models, and degrees of data abstraction; DBMS, RDBMS, Advantages and Disadvantages of DBMS	5
3	Database Design and ER-Diagram: overview, ER-Model, Constraints, ER-Diagrams, ERD Issues, weak entity sets, Codd's rules, Relational Schemas, Introduction to UML; Relational database model: Logical view of data, keys, and integrity rules, Relational Database design: features of good relational database design, atomic domain and Normalization (1NF, 2NF, 3NF, BCNF)	5
4	Relational Algebra: Introduction, Selection and projection, set operations, renaming, Joins, Division, syntax, semantics, Operators, grouping and ungrouping, relational comparison, calculus vs algebra	2
5	Constraints and Views: What are constraints, types of constraints, Integrity constraints, (Primary Key, Foreign Key, Check Constraint, Not Null, Altering Constraint, Concept of Backup Recovery); Introduction to views, data independence, security, updates on views, comparison between tables and views	4
6	PL/SQL: Introduction, Variables and types declaration, data definition; Data Types, DDL, DML, DCL, aggregate function, Null values, nested sub queries, joined relations, Triggers	3
7	Manipulating Dataset using SQL Statement: Basic Select Statement, Selecting Specific Column, Using Arithmetic Expressions, Defining Column Alias, using Where Clause	2
8	Restricting & Sorting Data: using Comparison Condition (=, <=, >=); Using Logical Operator: AND, OR, NOT, using BETWEEN, LIKE Conditions, Rule of Precedence, using Order by Clause	2
9	SQL Function: Displaying Data from Multiple Tables, Sub-Query, Concept of Function, Types, Group Functions, Use of Group by, Having Clause, Types of Joins, Concept of Sub-Query, Types of Sub-Queries	2

10	Spatial database systems and application: Exploring Spatial Geometry – Organizing spatial data – spatial data relationships and functionalities– Application program and user Interfaces, Overview of NoSQL for spatial data handling	2
11	Interface of Python with an SQL database Connecting, SQL with Python Creating, Database connectivity, Applications Performing - Insert, Update, Delete, queries, Display data by using fetchone(), fetchall(), rowcount()	1

Course Outcomes:

By the end of the course, students will be able to

1. describe the fundamental elements of relational database management systems.
2. explain the basic concepts of relational data model, entity-relationship model, relational database design, relational algebra and SQL.
3. design ER-models to represent simple database application scenarios.
4. extract data from database using SQL.
5. understand basic concept of spatial database.

Suggested Readings:

1. Connolly, T. M., & Begg, C. E. (2005). *Database systems: a practical approach to design, implementation, and management*. Pearson Education.
2. Deshpande, P. S. (2008): SQL & PL/SQL for Oracle 10g, Blackbook, Dreamtech Press, New Delhi
3. Ramakrishnan, R., Gehrke, J., & Gehrke, J. (2003). *Database management systems* (Vol. 3). New York: McGraw-Hill.
4. Silberschatz, A., Korth, H. F., & Sudarshan, S. (2011). Database system concepts.
5. Ullman, J. D. (1983). *Principles of database systems*. Galgotia publications.

Code: GIS 111	**Applied Statistics -I: Practicals**	
No. of Credits: 02		**No. of Practicals: 15**

Course Objectives:

1. To learn the different statistical techniques useful for research findings.
2. To understand the different statistical techniques practically.
3. To study comparison and conclusions of data.

Sr. No.	Topics	Practicals
1	Graphical representation of frequency distribution: Histogram, frequency curve, ogive curve	2
2	Measures of Central Tendency: Athematic mean, median and mode; Measures of Dispersion: Absolute and relative measures	3
3	Measure of skewness and kurtosis based on moments of distribution	3
4	Correlation and Regression: Scatter plot, Bivariate correlation example Regression: Bivariate linear and exponential	3
5	Matrix algebra: Matrix operations, types of matrices	4

Course Outcomes:

By the end of the course, students will be able to

1. understand analysis of data and drawing conclusions from it
2. understand how things are changing over time and to learn planning, designing, collecting data, analyzing, drawing meaningful interpretation and reporting of the research findings.

Note: a) For 2 credits 2 hours practical per week.
b) The concerned teacher may add some points related to the subject.

Suggested Readings:

1. Ebdon, D. (1977): Statistics in Geography, Basil Blackwell, Oxford
2. Frank, H. and Althoen, S.C. (1994): Statistics: Concepts Applications, Cambridge University Press,Cambridge
3. Gregory, S. (1978): Statistical Methods for Geographers, Longman, London
4. Hammond, R. and McCullagh, P. (1991): Quantitative Techniques in Geography, Clarendon Press, Oxford
5. Rogerson, P. A. (2010): Statistical Methods for Geography, Sage Publications, London

Code: GIS 112 Basic Programming Concepts

No. of Credits: 02 **No. of Lectures: 30**

Course Objectives:

1. To develops basic understanding of computers, the concept of algorithm and algorithmic thinking.
2. To develop the ability to analyze a problem, develop an algorithm to solve it.
3. To develop the use of the C programming language to implement various algorithms, and develops the basic concepts and terminology of programming in general.

Sr. No.	Topics	Lectures
1	Fundamental Concept: programming languages, Hardware and Software, Analog and Digital, Operating Systems	2
2	Introduction to computer: Introduction, Basic block diagram and functions of various components of computer, Concept of Hardware and Software, Types of software, Compiler and Interpreter	3
3	Introduction to programming language: machine language, assembly Language, high-level language, compilers and interpreters; Problem-solving using computers: Algorithms and flowcharts, Documentation, Comments, and Coding Style	3
4	The C Programming Language: Introduction, History of Programming Language, Basics elements, Variables, Basic I/O	2
5	Data Types and Operators, Control Structures, Types of Loops	5
6	Control Structures: Simple statements, Decision making statements, looping statements, Nesting of control structures, break and continue statement, go-to statements, Conditionals statements, Loops; Introduction to Functions	5
7	Introduction to Array and String: Single and Multidimensional Array, declaration and initialization of arrays, String storage, Built-in string functions, Collections and Dynamic Memory	5
8	Error Handling, File Handling: File I/O, Reading and Writing the Data to File	3
9	Concepts of Object-Oriented Programming: Fundamentals, Features - class, object, polymorphism, inheritance, data encapsulation and abstraction	2

Course Outcomes:

By the end of the course, students will be able to

1. understand the basic principles of computers.
2. understand the basics of binary computation.
3. understand the programming basics (operations, control structures, data types).
4. familiarize with basic C programming.
5. familiarize with the concept of object-oriented program.

Suggested Readings:

1. Balagurusamy, E. (2002): Programming in ANSI C, Tata McGraw Hill, New Delhi
2. Bjarne Stroustrup (2015): The C# Programming Language, 4th edition
3. Kanetkar, Y. (2001): Let Us C, BPB Publications, New Delhi
4. Kernighan, R. (1998): C Programming Language, (ANSI C Version), Prentice Hall, New Jersey
5. Malik D. S. (2009): "C# Programming Language", Cengage Learning

Code: GIS 113 **Basic Programming with Python**

No. of Credits: 02 **No. of Practicals: 15**

Course Objectives:

1. To master the fundamentals of writing Python scripts.
2. To learn core Python scripting elements such as variables and flow control structures.
3. To understand the object-oriented program design and development.
4. To work with common Python data types like integers, floats, strings, characters, lists.
5. To use basic flow control, including for loops and conditionals.

Sr. No.	Topics	Practicals
1	Introduction to Python: Comparison of Python with other languages like C/C++, Java etc, the execution model of Python, Salient features of Python, Areas where Python is in use, Industries that are using Python	1
2	Installing Python, Learning the syntax and semantics of Python, Using the Python interpreter, Python Keywords, Identifiers, Comments, Expressions, Statements, Input and Output, Type Conversion, Debugging, executing a Script, Structuring with Indentation, Editors	1
3	Data types and Variables: Naming convention of variables, Basic Input-Output Operations, Basic Operators	1
4	Control structures: Boolean Values, Conditional Execution, If/Else Statements, For/while Statements, Range () function, Break and continue statements, Else clauses on Loops, Pass statements, Operations, and Assignment statements	1
5	Functions: Define Function Statements with Parameters, Return Values and Return Statements, The None Value, Keyword Arguments and print (), Local and Global Scope, The global Statement, Lamda function	2
6	Data structures: List Data Type, Working with Lists, Augmented Assignment Operators, Methods, Stack, operations on stack (push and pop), Tuples, Set, Dictionaries and Structuring Data	2
7	Strings and String Methods: Working with Strings, Useful String Methods	1
8	File Handling: Files and File Paths, os.path Module, File Reading/Writing Process, Introduction to files, types of files (Text file, Binary file, CSV, excel file), relative and absolute paths	1
9	Modules and Packages: Standard modules, Packages, Defining Classes, defining functions, Creating Modules and Packages, importing a module, Import the names, Executing modules as scripts	1
10	Data Visualization: Basic data visualization with Matplotlib, Line Charts, Bar Graphs, Histograms, Scatter Plots, 3D plots, Heat maps	2
11	Finding and Fixing Code Bugs: Error handling and fixing bugs	1

12	Object-oriented design: Object-Oriented Approach, Classes, Methods, Standard Objective Features; Exception Handling, and Working with Files	1

Course Outcomes:

By the end of the course, students will be able to

1. develop algorithmic solutions to simple computational problems.
2. demonstrate programs using simple Python statements and expressions.
3. explain control flow and functions concept in Python for solving problems.
4. use Python data structures lists, tuples and dictionaries for representing compound data.
5. explain files, exception, modules and packages in Python for solving problems.

Note: a) For 2 credits 2 hours practical per week.
b) The concerned teacher may add some points related to the subject.

Suggested Readings:

1. Barry, P. (2016). *Head first Python: A brain-friendly guide*. " O'Reilly Media, Inc.".
2. Chun, W. (2001). *Core python programming* (Vol. 1). Prentice Hall Professional.
3. Lutz, M. (2013). *Learning python: Powerful object-oriented programming*. " O'Reilly Media, Inc.".
4. Phillips, D. (2010). *Python 3 object-oriented programming*. Packt Publishing Ltd.
5. Sweigart, A. (2019). *Automate the boring stuff with Python: practical programming for total beginners*. No Starch Press.

Code: GIS 121 **Research Methodology**

No. of Credits: 04 **No. of Lectures: 60**

Course Objectives:

1. To understand the fundamental principles of the research.
2. To differentiate between different types if research.
3. To evaluate research design.
4. To set or develop hypothesis.
5. To select appropriate data collection method.
6. To apply research methodology to real world problems.

Sr. No.	Topics	Lectures
1.	Methods of Geospatial Studies, Research: Definition, Types, Classification, Literature Review, Case Studies	10
2.	Methods of Explanation: Inductive, Deductive, Empiricism, Positivism, Hempel	4
3.	Hypothesis, Theories, Laws and Models	4
4.	Research Question, Objectives, Significance of Research, Research Design	6
5.	Data Collection: Types, Methods, Tools and Techniques	5
6.	Recent Trends in RS and GIS Research	4
7.	Ethics in Scientific Research and Plagiarism	4
8.	Scientific Journals: Impact Factor, Citation,	3
9.	Introduction to useful online platforms: Mendeley, Google Scholar, ResearchGate, Shodhganga	4
10.	Research Proposal	4
11.	Presentation of Research Findings: Report Writing, Presentation and Formatting	4
12.	Citations, References, Bibliography and various referencing styles	4
13.	Evaluation of Research: Criteria of evaluation	4

Course Outcomes:

By the end of the course, students will be able to

1. equip with the foundation skills and competencies needed to embark on their research journey successful.
2. master research methodology.
3. to conduct meaningful research in their academic and professional endeavors.

Suggested Readings:

1. Gomez, B. and Jones, J. P. III (2010): Research Methods in Geography: A Critical Introduction, John Wiley and Sons
2. Goudie, A. (Ed) (2004): Encyclopedia of Geomorphology, Routledge, London

3. Gregory, D., Johnston, R., Pratt, G., Watts, M. and Whatmore, S. (2009): The Dictionary of Human Geography, Wiley-Blackwell, Singapore
4. Montello, D. and Sutton, P. (2013): An Introduction to Scientific Research Methods in Geography and Environmental Studies, SAGE Publications
5. Warf, B. (Ed) (2006): Encyclopedia of Human Geography, SAGE Publications, London

Year-I
Semester-II

Code: GIS 201 **Digital Image Processing**

No. of Credits: 04 **No. of Lectures: 60**

Course Objectives:

1. To learn the interpretation of remote sensing images,
2. To understand numerous image processing and analysis techniques
3. To understand methods or algorithms to usage is determined by the objectives of each specific requirement.
4. To learn creation of new themed maps by combining multiple data layers in a computer.

Sr. No.	Topics	Lectures
1	Introduction to Digital Image Processing: Digital images, Types Sources of Errors, Atmospheric, Radiometric and Geometric; Image Rectification: Geometric Correction, Radiometric, Correction, Noise Removal	10
2	Image Enhancement Techniques: Contrast Enhancement, Linear, Non-Linear, Logarithmic and Exponential, Gaussian Stretch, Density Slicing; Spatial Filtering: Low Frequency, High Frequency,Edge Enhancement, Band Ratio and Band Combination	10
3	Digital Image Classification: Classification Scheme, Supervised Classification, Training Sites Selection, Classifier types, Unsupervised Classification, Accuracy Assessment	10
4	Object-oriented classification: Segmentation, Object-oriented vs. pixel-based classification, Algorithms for classification	4
5	Introduction to ERDAS	2
7	Familiarization with Image Processing Systems: Loading of Image Data, Identification of Objects on Visual Display, Study of Histograms and Layer Information	4
8	Image Enhancement Techniques: Linear and Non-Linear Contrast Enhancement, Band Ratioing, Edge Enhancement, High and Low Pass Filtering, Density Slicing	4
9	Image Registration: Registration of Bases Map/ Topomap, Image to Map, Image to Image	4
10	Image Classification: Supervised, Unsupervised and Use of Different Algorithms, Change Detection	4
11	Accuracy Analysis: Producer, User Accuracy, Overall and Mapping Accuracy, Kappa Coefficient	4
12	Vector Layers: Generation of Vector Layer, Editing and Topology Building, Area and Perimeter Estimation; Map Composition	4

Course Outcomes:

By the end of the course, students will be able to

1. extract additional information from geographical data that might not be obvious simply by looking at a map.
2. understand how efficiently they can encode, save, retrieve, overlay, correlate, alter, analyze, query, and display geographical data. Digital image processing,

	visual inspection is a crucial component, and the results of these methods and also learn to gather data from the images.

Suggested Readings:

1. Cha, B., Dattaa, D., Majumdar (2001): Digital Image Processing Analysis, Prentice-Hall of India, NewDelhi
2. Jensen, J. R. (2005): Introductory Digital Image Processing, Prentice Hall,NewJersey
3. Lillesand, T. M., Kiefer, R. W.Chipman, J. W.(2008): Remote Sensing and Image Interpretation, JohnWiley & Sons, New Delhi
4. Nag, P. Kudrat, M. (1998): Digital Remote Sensing, Concept Publishing Company, New Delhi
5. Richards, J. A, Jia,X.(1999):Remote Sensing and Digital Image Processing, Springer, Verlag Berlin

Code: GIS 202 Geospatial Analysis

No. of Credits:04 **No. of Lectures: 60**

Course Objectives

1. To learn spatial data visualization techniques and cartography.
2. To learn geo-processing tools.
3. To learn about GIS and decision-making.
4. To learn about surface analysis.
5. To learn about 3D modelling and analysis.

Sr. No.	Topics	Lectures
1	Introduction to Spatial Analysis: Significance of Spatial Analysis, Overview of Tools for Analysis	3
2	Data Conversion, Creation and Extraction: Netcdf, .h5, JSON, CAD, excel, KML/KMZ, dbase, raster, shapefile	3
3	Vector Analysis: Overlay Operations: Point-in-Polygon, Line-in-Polygon, Polygon-in-Polygon; Single Layer Operations: Feature Identification, Extraction, Classification Manipulation; Multilayer Operation: Union, Intersection, Symmetrical Difference, Update, Merge, Append and Dissolve, geometry and related operations	10
4	Raster Analysis: Map Algebra, Grid Based Operations, Local, Focal, Zonal and Global Functions, Cost Surface Analysis, Optimal Path and Proximity Search, Attribute table, Mask, Reclassify, resample, raster mosaic, merge, extract bands	6
5	Spatial Network and Location Analysis: Concepts, Evaluation of Network Complexity Using Alpha-Gamma Indices, C-Matrices for Evaluating Connectivity of the Network, Network Data Model, Path Analysis, Types of Network Analysis, Optimum Cyclic Path, Vehicle Routing, Path Determination and Cost-Path Analysis	8
6	Geocoding and Reverse geocoding	3
7	Point Pattern Analysis: Methods for Evaluating Point Pattern, Clustered and Random Distribution, Density Analysis, Distance related operations	8
8	Surface and Grid Analysis: DEM, TIN, Slope, Aspect, Hill shade and viewshed, creating 3D data, mapping, animation	5
9	Geostatistics: Interpolation Methods - Trend Surface Analysis, IDW, Kriging, Measures of Arrangement and Dispersion, Autocorrelation, Semi-Variogram	6
10	Spatial Modeling: Role of Spatial Model, Explanative, Predictive and Normative Models, Correlation-Regression Analysis in Model Building, Handling Complex Spatial Query and case Studies	6
11	Big Data and Geospatial Analysis: Types and Challenges	2

Course Outcomes:

By the end of the course, students will be able to

1. apply a range of geospatial analysis techniques using remote sensing and GIS tools toward solving quantitative problems in one or more core disciplinary areas such as geography, ecology, environmental sciences, bio-geosciences, urban planning, natural resources management etc.
2. quantitatively analyze data to evaluate scientific hypotheses and arguments in remote sensing and geographic information science.

Suggested Readings:

1. Booth, B., Shaner, J., MacDonald, A., Sanchez, P. Pfaff, R. (2004): ArcGIS, Geodatabase Workbook, Redlands
2. Environmental Systems Research Institute, Inc. (1998): Understanding GIS: The Arc/Info Method, ESRI Press, Redlands.
3. ESRI (2003): Introduction to ArcGIS- I, Course Lectures, GIS Education Solutions
4. Makrewski, J. (1999): GIS Multi-criteria Analysis, John Wiley and Sons, New York
5. Melania, H. M., Rhonda, P., Minami, M., Hatakeyama, A. M. (2004): ArcGIS, Using ArcMap, ESRI Press, Redlands

Code: GIS 203 Advance Surveying and Fieldwork: Theory

No. of Credits: 02 **No. of Lectures: 30**

Course Objectives:

1. To understand advanced surveying concepts.
2. To utilize modern surveying instruments.
3. To plan and execute field survey.
4. To analyze and process survey data.
5. To apply surveying in various domains.

Sr. No.	Topics	Lectures
1	Introduction to Differential GPS (DGPS): Principle and Function	3
2	Single and Dual Frequency DGPS, RTK and Static Surveys in DGPS, Use of DGPS in Topographical Survey	6
3	Introduction to Total Station: Principle and Function	3
4	REM, RDM, Use of Total Station for data processing and analysis	6
5	Comparison of Total Station with DGPS in Topographical Surveying	5
6	Introduction to Unmanned Aerial Vehicle (UAV): Principles and Functions	3
7	Types of UAV, DGCA directions and rules	4

Course Outcomes:

By the end of the course, students will be able to

1. handle advanced survey instruments such as Total Station, DGPS, and UAVs.
2. conduct surveys and collect the required data.
3. analyze the data and produce the results.
4. correlate and compare the data from various sources.
5. integrate remote sensing data, such as aerial and satellite imagery, LiDAR and other remote sensing technology into surveying projects for enhanced spatial information.

Suggested Readings:

1. Jeff, H. (1995): Differential GPS Explained, Trimble Navigation
2. Lawrence, L. and Alex, L. (2008): GPS Made Easy: Using Global Positioning Systems in the Outdoors, Rocky Mountain Books, Calgary
3. Mohinder, S. G., Lawrence, R. W. and Angus, P. A. (2001): Global Positioning Systems, Inertial Navigation and Integration, John Wiley and Sons Inc., New York
4. Satheesh, G., Sathikumar, R. and Madhu, N. (2007): Advanced Surveying: Total Station, GIS and Remote Sensing, Pearson Education, Delhi
5. Stinespring, B. M. (2000): The Experimental Evaluation of a DGPS Based Navigational System for the ARIES AUV, Monterey, California: Naval Postgraduate School; Springfield.

Code: GIS 204 Advanced Surveying and Fieldwork: Practicals

No. of Credits: 02 **No. of Practicals: 15**

Course Objectives:

1. To understand advanced surveying concepts.
2. To utilize modern surveying instruments.
3. To plan and execute field survey.
4. To analyze and process survey data.
5. To apply surveying in various domains.

Sr. No.	Topics	Practicals
1	Introduction to Differential GPS (DGPS): DGPS setting of Instruments at base and rover, DGPS Survey and Data Processing, Generation of digital elevation model (DEM)	5
2	Introduction to Total Station: REM, RDM, Use of Total station for data collection, processing, and analysis	5
4	Introduction to Unmanned Aerial Vehicle (UAV): Drone survey, Data Collection, Data processing, DEM, DSM, DTM generation	5

Course Outcomes:

By the end of the course, students will be able to

1. handle advanced survey instruments such as Total station, DGPS, UAV.
2. conduct survey and collect the required data.
3. analyze the data and produce the results.
4. corelate and compare the data from various sources.
5. integrate remote sensing data, such as aerial and satellite imagery, LiDAR and other remote sensing technology into surveying projects for enhanced spatial information.

Note: a) For 2 credits, 2 hours practical per week.
b) The concerned teacher may add some points related to the subject.

Suggested Readings:

1. Jeff, H. (1995): Differential GPS Explained, Trimble Navigation
2. Lawrence, L. and Alex, L. (2008): GPS Made Easy: Using Global Positioning Systems in the Outdoors, Rocky Mountain Books, Calgary
3. Mohinder, S. G., Lawrence, R. W. and Angus, P. A. (2001): Global Positioning Systems, Inertial Navigation and Integration, John Wiley and Sons Inc., New York
4. Satheesh, G., Sathikumar, R. and Madhu, N. (2007): Advanced Surveying: Total Station, GIS and Remote Sensing, Pearson Education, Delhi
5. Stinespring, B. M. (2000): The Experimental Evaluation of a DGPS Based Navigational System for the ARIES AUV, Monterey, California: Naval Postgraduate School; Springfield.

Code: GIS 205 **Open Source GIS - I**

No. of Credits: 02 **No. Practicals: 15**

Course Objectives:

1. To explore open-source GIS concepts their importance.
2. To acquire and manage open-source GIS data.
3. To perform spatial analysis in open-source GIS.
4. To understand the integration of open-source tools.
5. To apply open-source GIS to real world problems solving.

Sr. No.	Topics	Practicals
1	Open Source GIS: Basic Concepts, OGC/ISO Protocols; Introduction to Open Source Software	2
2	Introduction to QGIS Graphical User Interface: Menu Bar, Toolbars, Panels, Map, View, Status Bar, Browser Panel, Plugins - Installing and Managing Plugins, QGIS Configuration	2
3	Generation of Vector Layers: Point, Line, Polygon	3
4	Georeferencing, Projection and Reprojection, Handling broken file paths	3
5	Working with Vector Data: Vector Properties Dialog, Working with Attribute Table, Editing, Vector Tiles, Query Analysis	3
6	Working with Raster Data: projection, band combination, layer stacking, Map Composition	2

Course Outcomes:

By the end of the course, students will be able to

1. understand the concept and philosophy of the open source.
2. harness the power of open source GIS tools for a wide range of applications in their academic and professional endeavors**.**

Note: a) For 2 credits, 2 hours practical per week.

b) The concerned teacher may add some points related to the subject.

Suggested Readings:

1. Andrew Cutts, Anita Graser (2018): Learn QGIS, https://www.packtpub.com/application-development/learn-qgis-fourth-edition
2. Markus Neteler And Helena Mitasova (2007): Open Source GIS: A GRASS approach, Springer-Verlag Berlin, Heidelberg

Code: GIS 211 Applied Statistics – II: Practicals

No. of Credits: 02 **No. of Practicals: 15**

Course Objectives:

1. To understand GIS and geo statistical techniques, tools and approaches for spatial analysis.
2. To enhances the knowledge about distribution of spatial data.
3. To learn the how to do predictions for a better understanding of the available information.

Sr. No.	Topics	Practicals
1	Geographical Data and Multivariate Analysis	1
2	Trend Surface Analysis: Computation of Linear Trend and Ideas of Quadratic and Cubic Surfaces	3
3	Principal component analysis (PCA), Factor Analysis	4
4	Introduction to R software: Exploratory data analysis, Probability and statistical operations, Regression and least squares using R	3
5	Geostatistics: Point data interpolation techniques including kriging methods - Simple kriging, Ordinary kriging, Universal kriging	4

Course Outcomes:

By the end of the course, students will be able to

1. understand the geostatistical methods and their application in different GIS domain, spatial trends in the data, or whether the features form spatial patterns.
2. analyze and predict the values associated with spatial or spatio-temporal phenomena.
3. enhance their knowledge about recent trends in geostatistics and it will offer convenient management in the related field.

Note: a) For 2 credits 2 hours practical per week.
b) The concerned teacher may add some points related to the subject.

Suggested Readings:

1. Acevedo, M. F. (2012). *Data Analysis and Statistics for Geography, Environmental Science and Engineering.* London: CRC Press.
2. Hammond, R. and McCullagh, P. (1991): Quantitative Techniques in Geography, Clarendon Press, Oxford
3. Johnston, R. J. (1978). *Multivariate Statistics in Geography*. London: Longman.
4. Rogerson, P. A. (2010). *Statistical Methods for Geography*, London: Sage Publications

Code: GIS 212 Advance Programming with Python

No. of Credits: 02 **No. of Practicals: 15**

Course Objectives:

1. To master the numeric data processing with Python scripts.
2. To learn geospatial data analysis using python.
3. To learn to create API and web application using Python.
4. To work with GUIs and web browsers with Python.

Sr. No.	Topics	Practicals
1	NumPy and SciPy: Introduction to NumPy, Creation of vectors and matrices, Matrix manipulation	2
2	Pandas: Introduction, Pandas data structures – Series and DataFrame, Data wrangling, loading a dataset into a DataFrame, Selecting Columns, Selecting Rows, Adding/ Deleting new data in a DataFrame, manipulation of tabular data	2
3	Data Visualization: Matplotlib and Seaborn	1
4	GeoPandas: Introduction, Installation, Vector data processing, reading/writing shapefile, plotting, clip, overlay, spatial join, choropleth maps, classification	2
5	Rasterio: Introduction, Installation, opening data, read, save, georeferenced and visualize raster files, spatial indexing, creating data	2
6	Scikit-Learn: for machine learning, model fitting, predicting, cross-validation, for predictive data analysis, Tensor Flow, Pytorch	2
7	GUIs in Python: Tkinter, Introduction, components and events, example of GUI, root component, adding button, entry widgets, Text widgets, check buttons	1
8	Web Scraping: Beautiful Soap, python web browser Module, Downloading Files from the Web with the requests Module, Saving downloaded Files to the Hard Drive, HTML	1
9	Django: Overview, Installation, Creating Project, creating application, database and views, static files and forms, API and security	1
10	ESRI ArcGIS API for Python	1

Course Outcomes:

By the end of the course, students will be able to

1. understand the concept of numerical python, manipulate and extract data from pandas DataFrames.
2. write Python code according to standard style guidelines.
3. master basic processing of Raster and vector data in python.
4. familiarize themselves with python GUI's and data processing with sklearn.
5. understand the concept of Django and ESRI API for python.

Note: a) For 2 credits 2 hours practical per week.

b) The concerned teacher may add some points related to the subject.

Suggested Readings:

1. Beazley, D., & Jones, B. K. (2013). *Python Cookbook: Recipes for Mastering Python 3*. " O'Reilly Media, Inc."
2. Kanetkar, Y. (2019). *Let Us Python*. BPB Publications
3. Lutz, M. (2010). *Programming Python: powerful object-oriented programming*. " O'Reilly Media, Inc."
4. McKinney, W. (2012). *Python for data analysis: Data wrangling with Pandas, NumPy, and IPython*. " O'Reilly Media, Inc".

Code: GIS 213 Cartography and Data Representation

No. of Credits: 02 **No. of Practicals: 15**

Course Objectives:

1. To learn the representation of the region in a short scale.
2. To understand display/represent graphic information using GIS system.
3. To learn easier data symbolization.
4. To learn different types and component of geographical maps.
5. To develop a map in a detailed manner easily and digitally.

Sr. No.	Topics	Practicals
1	Introduction to Cartography and Elements of Map Design	2
2	Map Projection and Coordinate system: Concepts, Types and Uses	4
3	Scales of Measurement: Nominal, Ordinal, Interval, Ratio; Graphical Representation of Statistical Data: Two- and Three-dimensional diagrams	4
4	Map types: Thematic, Topographical, Cadastral; Interpretation of SOI Topographical Maps: Identification and Visualization of different Physical and Manmade Features	3
5	Digital Cartography and Digital Data Representation	2

Course Outcomes:

By the end of the course, students will be able to

1. understand the all aspects of handling geographical information, also it provides a simple platform to understand most of the geographical phenomena and the occurrence of these phenomena.
2. perform map making and will understand how to apply patterns and colors when representing features on a map.

Note: a) For 2 credits 2 hours practical per week.
b) The concerned teacher may add some points related to the subject.

Suggested Readings:

1. Gupta, K. K. Tyagi, (1992): Working with maps, Survey of India Publication, DST, New Delhi
2. Monkhouse, F. J., & Wilkinson, H. R. (1963). Maps and diagrams: their compilation and construction. Egmont Books Ltd
3. Ramamurthy, K. (1982): Map Interpretation, Rex Printers, Madras
4. Robinson, A. H., Morrison, J. L., Muehrcke, P. C., Kimerling, A. J. Guptill, S. C. (1995): Elements of Cartography, Wiley, New York
5. Singh, R. L. (1979): Elements of Practical Geography, Kalyani Publishers, New Delhi
6. Understanding Map Projection (2003-2004): GIS by ESRI, Redlands.

Code: GIS 214 Applications of GIS and Remote Sensing

No. of Credits: 02 **No. of Lectures: 30**

Course Objectives:

1. To learn the applications of remote sensing data and GIS techniques in different fields.
2. To understand periodic updates in various fields.
3. To monitor the environment and human activities using RS and GIS techniques.

Sr. No.	Topics	Lectures
1	Geosciences: Landform Analysis, Drainage Basin Morphometry, Slope Mapping, Integrated Approach for Landslide Hazard Zonation Models and Mapping	5
2	Water Resources: Watershed Hydrology, Physical Processes in Watershed, River Valley Project, Hydrological Modeling	4
3	Forest: Image Processing for Forest, Vegetation Classification Mapping, Forest Inventory, Forest Management, Land Evaluation for Forestry	4
4	Marine and Atmospheric Sciences: Fundamentals, Oil Spills, Ecology, Ocean Color Mapping, SST Mapping, Potential Fishing Zone Mapping	5
5	Fundamental of Climatology: Aerosols, Climate modeling, Meteorological Satellites, Forecasting of Natural Calamities, Climate change detection	4
6	Agriculture and Soils: Spectral Characteristics of Crop, Crop Inventory, Crop Yield Modeling, Soil Mapping, Crop Water Management, Agro-Ecological Zoning	4
7	Biodiversity: Concept of Ecology and Biodiversity, Biodiversity Mapping, Assessment of Biodiversity Hotspots, Wildlife Habitat Suitability Analysis, Species Inventory	4

Course Outcomes:

By the end of the course, students will be able to

1. understand how remote sensing data and GIS techniques are efficient to find and analyze real world problem in the different fields and it will help for decision making to minimize problem and for their management.
2. understand Satellite imaging helps detect environmental and structural changes in various sites.

Suggested Readings:

1. Deekshatulu, B. L. (1990): Description and useofLand use/Landcover, NRSA, Hyedrabad
2. Harris, J. E. (1990): Earthwatch – The Climate from space, Ellishorwood Ltd., Midsower Norton
3. Lal, D. S. (1998): Climatology, Chaitanya Publishing House, Allahabad
4. SPRS Technical Commission VII (2002): Symposium on Resource Environmental Monitoring, ISRS Annual Convention, IIRS, Dehradun
5. Roy, P.S., Dwivedi, R. S. (2010): Remote Sensing Application www.nrsc.gov.in/Learning-Center, E Book. html

Code: GIS 221 **On Job Training**

No. of Credits: 04

On Job Training (OJT) in the RS and GIS field aims to provide necessary knowledge and practical skills to excel in their RS and GIS roles. The objectives of OJT in RS and GIS are as follows.

1. To understand spatial data management and perform spatial analysis.
2. To interpret remote sensing imagery.
3. To apply RS and GIS in real world problems.
4. To enhance problem solving skills.
5. To foster collaboration and communication.
6. To emphasize data ethics and privacy.
7. To embrace emerging technology.

By considering on these objectives, OJT in the RS and GIS field equips employees with the necessary skills and knowledge to contribute effectively to geospatial projects, making them valuable assets in the organization's geospatial endeavors.

Guidelines

1. For On Job Training, the students will be attached with various institutions and employing establishments, which have laboratory/workshop, other related facilities and where adequate supervision by qualified personnel will be available.
2. A student is expected to spend not less than 60 working hours on On Job Training and related activities.
3. On Job Training will be carried out in summer vacation after the students complete their second semester examinations.
4. Students need to provide the confirmation letter from the organization or the institute where they have joined for On Job Training.
5. Continuous evaluation of the students' performance in the On Job Training will be carried out with the assistance of the personnel of training institutions/employing establishments where this training will be imparted.
6. The proof of completion of On Job Training (work experience certificate and field report) should be submitted during examination to the parent institution, duly issued and signed by the concerned training authority.

Course Outcomes:

By the end of the course, students will be able to

1. apply the principles of RS and GIS in real-world projects.
2. solve problems and enhance their critical thinking skills.
3. effectively communicate and collaborate with corporate industries.
4. adapt to emerging RS and GIS technology.
5. embrace different pathways of learning, including experiential learning.
6. understand the social, economic and administrative considerations that influence the working environment of different organizations.
7. learn new strategies like time management, multi-tasking and new skills.
8. get an opportunity to meet new people and learn networking skills.